



NASA STTR 2005 Phase I Solicitation

T5.02 Robotics and Virtual Digital Human Technologies

Lead Center: JSC

An Integrated Approach with Digital Virtual Humans(DVH) and Robotic Simulations

NASA is targeting a new level in space exploration operations. Critical advancements in crew and ground support technologies will be needed as NASA develops new operational capabilities to support multiple-manned, robotic, and long-duration/distance missions. Two potential areas for research are the ever-evolving Robotics and 3D DVH training procedures and simulation technologies providing operational robustness and intelligence. Furthermore, advanced capabilities for information integration and real-time interaction provide foundation for more simulation interaction between the two technologies. More advanced inter-system support capabilities (performance, maintenance, etc.) coordinated with a reliable knowledge base will be needed.

Proposals that improve operator efficiency via advanced displays, controls, and telepresence interfaces and improve the ability of humans and computers to seamlessly control robotic systems are sought. Specific technology requirements include the following hardware:

- Thermal feedback device for protecting the Robotic End-Of-Effector from grasping a hot/cold object that will damage its hand;
- Tactile feedback interface for collision awareness between workspace and avatar objects and robotic structure;
- Force feedback device for operator awareness of manipulator and payload inertia, gripping/slipping force, and forces and moments due to contact with external objects;
- Stereographic/autostereoscopic display systems for high-fidelity depth perception, field of view, and high resolution; and
- Spatial tracking for user appendages (i.e., head, arms, legs, fingers, and eyes) and avatar/robotic motion.

Based on the new Mission Control Center System (MCCS) Architecture framework, integrated support for Digital Virtual Human (DVH) in the loop and teleoperational interfaces are also the focus of this solicitation. Proposals offering innovation in the form of 3D visualization and simulation capabilities of robotic systems (direct manipulation, telerobotics, telepresence, etc.) with relation to the 3D DVH in the loop concept are being sought. The application targets would be flight and ground operations development, analyses, planning, training, and support. The main result desired is an interactive system that enhances operator and IVA/EVA procedure tasks

efficiency via the teleoperational technologies and distributed collaborative virtual environments. The introduction of the DVH in a Virtual Reality (VR) robotic scenario is necessary for task and robotic device design, development, testing, planning, training, and operations functioning as integrated systems.

The core element of this project is the implementation of the Digital Virtual Human (DVH). This innovative human modeling technology comprises a combination of anatomical, biomechanical, and anthropometric functionality to fully simulate the somatic components and systems of the human body. Based on the tenets of the Visible Human Project, this DVH technology provides the opportunity to simulate real-world problems on the DVH in a simulated, virtual environment (VE) interfacing with virtual objects. The main objective is to apply a high-fidelity DVH in a scenario that "re-creates" a real world. Scenes involving the DVH imply rich, complex problems to solve, visualize, and predict outcomes. The DVHs will have a key role in Shared VEs and truly interactive scenarios based on real-time data/information. More complex DVH embodiment increases natural interaction within the environment. The users' more natural perception of each other (and of autonomous actors/avatars) increases their sense of being together and thus the overall sense of shared presence in the environment.

Immersive technologies such as Virtual Reality (VR), Digital Virtual Human (DVH), and 3D DVH training procedure and simulation modeling have become a significant vehicle for NASA's effort to generate and communicate knowledge/understanding to K-12 levels through university/academic institutions to continuing education modalities. The ability to share aerospace-related operation simulations such as International Space Station and Space Shuttle/Space Transport System (STS) operations, robotics, intravehicular/extravehicular activities, Mission Control Center Systems (MCCS) conduct, interplanetary space flight, and microgravity simulation provides opportunity for educational and commercial growth for NASA and its research and development partners.

Human/Robotic Operations in Space

- Small, low power machine advanced vision systems for tracking a moving, articulated object;
- Machine vision techniques including the construction of image mosaics, for detection of unspecified changes in objects being inspected under diverse or changing lighting and viewing conditions;
- Small, lower power, range/range-rate sensors;
- Control interfaces that allow for seamless human/robot operations;
- 3D path planning systems and intelligent trajectory assessment feedback during teleoperations;
- Miniaturized motor control and drive electronics;
- Miniaturized sensing systems for manipulator position, rate, acceleration, force and torque; and
- Reduced-part-count miniaturized propulsion hardware (e.g., compressed gas storage with output pressure regulation via valve control only).

